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TARGETED STRATEGIC TRADE POLICY WITH DOMESTIC COST HETEROGENEITY.

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Abstract

This paper examines optimal strategic trade policy under oligopoly with many home and foreign firms when firms have different levels of efficiency and a trade-off exists between the subsidy bill and firms' profits. The first-best policy involves a structure of firm-specific export subsidies and export taxes in which the government favours the most efficient firms unless the social cost of funds is sufficiently high. When the policy is constrained to a uniform subsidy, the optimal policy depends on the relative number of home and foreign firms and on the curvature of demand. Deficiencies of the uniform subsidy are examined.

(99 words)

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Targeted Strategic Trade Policy With

Domestic Cost Heterogeneity

1. Introduction

Even a casual observation of the real world suggests that firms within the same industry differ in their market shares and performance. Economic theory has often assumed these differences to be temporary, and that they would be eliminated by a natural process of diffusion of organisational practices and technical knowledge. This conclusion, however, is at odds with the evidence emerging from empirical studies which suggests a long-run persistence of inter-firm differences in size and performance within a given industry[1].

Only recently has theoretical work started to investigate how differences in firms' performance can be sustained over time and are not eliminated by entry and/or exit. In models set in the evolutionary tradition history plays a decisive role in shaping and maintaining differences in efficiency and performance between firms. Within this framework, Rosenberg (1982), Nelson and Winter (1982) and Dosi (1988) argue that technology, defined in a broad sense and seen as being embodied in people and organisations, reflects specific and only partially appropriable cumulative knowledge. The role of history is also crucial in models set in a more orthodox framework, where rational firms are subject to random shocks to technology as in Jovanovic (1982) or to demand as in Fishman and Rob (1995). In Kreps and Spence (1985) firm-specific strategies and performances result from the different conjectures firms make about their competitors' behaviour. Demsetz (1973) ascribes the existence of persistent technological differences between firms to the fact that competitors may lack the knowledge to imitate the technology of the most successful firms. Lippman and Rumelt (1982) show, within a perfectly competitive framework, how uncertainty as to firms' efficiency prior to entry can lead to persistent inter-firm differences in profitability.

[1] Mueller (1986) found persistent long-run profitability differences amongst US firm within industries. Cubbin and Geroski (1987) and Mueller (1990) confirmed these findings for the U.K.. See also Clark and Fujimono (1991) for evidence on the auto industry.

These contributions in the recent industrial organisation literature are concerned with the sources of the persistent nature of differences between firms. When used in other areas of the theoretical literature, however, imperfectly competitive market structures are normally characterised by the assumption of firms' homogeneity[2]. The literature on strategic trade policy and international trade under oligopoly is no exception to this general pattern and until now it has almost always assumed that all firms in a particular country are identical[3].

In this paper, we construct a model which extends the work of Dixit (1984), Markusen and Venables (1988), Collie (1991) and Thursby and Krishna (1991) on many firms oligopoly trade models. All these previous authors imposed symmetry among firms within countries. Instead, we examine trade policy for oligopolistic industries where firms are characterised by different marginal costs.

Cost asymmetries among firms have been introduced by Collie (1993, 1998), Lahiri and Ono (1995), and Van Long and Soubeyran (1997) who assume that national industries are made up of heterogeneous firms. However, Lahiri and Ono (1995) do not carry out a full trade policy analysis and Collie (1993) and Long and Soubeyran (1997), though they examine strategic trade issues, do not analyse the first-best policy[4], which we will show consists of a vector of firm specific subsidies. In fact, only when firms have identical marginal costs can the first-best be achieved with a uniform subsidy. The drawbacks of uniform subsidisation only become an issue when firms differ in terms of their efficiency. In that case the government can do better by using

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[2] For a closed economy analysis of oligopoly with heterogeneous firms see Cowling and Waterson (1976), Lahiri and Ono (1988) and Kimmel (1992). Montagna (1995) examines firm heterogeneity in a monopolistic competition model.

[3] See Brander (1995) for a recent survey of the literature on strategic trade policy.

[4] Lahiri and Ono (1995) restrict attention to normative consequences of the exiting of a minor (high cost) firm from the market. They find that this always benefits a country if the country is an exporter of the good produced by this firm. Collie (1998) analyses the welfare effects and compares the efficiency of uniform ad valorem and specific (per-unit) trade policy instruments. He finds that while an ad valorem production subsidy yields lower welfare than a per-unit production subsidy, combining uniform ad valorem and per-unit instruments yields welfare gains.

a structure of firm-specific subsidies. A similar distinction between firm-specific and uniform subsidies is made by Rodrik (1989). However, he compares optimal firm-specific and uniform taxes in a model where there are no foreign competitors and hence no strategic trade considerations arise.

The acknowledgement of inter-firm differences raises important questions in the field of trade policy. The strategic trade policy literature suggests that an active intervention may be desirable if domestic firms' profits can be increased at the expense of foreign competitors. Recently, Neary (1994) considers an international duopoly and argues that if there exist inter-country differences in marginal costs, government assistance should be targeted towards those industries which have a *"comparative advantage in profit shifting"*; in other words, policy should favour those domestic industries in which firms have a cost advantage over their foreign rivals[5].

Neary, however does not address the important issue of the nature of an optimal intervention in cases where differences in efficiency exist *between domestic firms within industries*. Should the government reduce firm heterogeneity in the industry by helping the weaker more than the stronger firms? Or should it pursue the opposite policy of picking-winners? The purpose of this paper is to examine these issues. We find, somewhat surprisingly that the picking of winners results will be reversed at moderately high social costs of funds.

In the strategic trade policy literature it is generally assumed that the social cost of public funds is unity. That is, equal weight is placed on government subsidy expenditure and the domestic private profits generated by the home firms. However, as has recently been pointed out by Gruenspecht (1988) and Neary (1994), there are several reasons for regarding this as a rather special case. First, a cost is incurred by society in the process of transferring purchasing power from the taxpayers to the government. Several components of this cost can be identified, such as deadweight losses caused by taxpayers activities aimed at reducing the tax burden, and the administrative costs associated with the managing of the tax administration. Second, political economy and distributional considerations may also imply that profits are attached a lower social value than the other incomes taxed to finance the subsidy bill. Third, if the firms are partially

[5] Within a similar framework, Bandyopadhyay (1997) analyses the interaction of international cost asymmetries and demand elasticities in determining the direction of strategic trade policy.

foreign owned, not all the profits will accrue to domestic residents. To take account of these factors, in this paper we allow for an asymmetry between private and social costs and we show how the nature of the optimal policy in general and the radicality of the pick-the-winner prescription in particular are affected.

The plan of the paper is as follows. Section 2 introduces the model. The strategic trade policy analysis is carried out in Section 3 where the effect of the asymmetry between social and private costs is analysed. Section 4 draws some conclusions and charts future directions in research.

2. The Model

We consider a model in which n home firms and n^* foreign firms export a homogeneous commodity to a third market. The inverse demand function which is twice differentiable is:

$$p(Q), \quad p'(Q) = -b(Q) < 0 \tag{1}$$

where Q is total industry sales. Firms have different but constant marginal costs represented by c_i for a typical home firm and c_k^* for a typical foreign firm. Profits for a typical home firm from exports to the third market are:

$$\pi_i = (p - c_i + s_i) q_i, \tag{2}$$

where is a firm-specific export subsidy and q_i is the quantity produced by firm i. We follow Brander and Spencer (1985) and Eaton and Grossman (1986) in restricting attention to competition on the export market and assume no links with any other market, in order to concentrate on strategic trade policy issues and abstract from the welfare implications of domestic consumption. Entry and exit of firms are ruled out by assumption and fixed costs (which may account for the oligopolistic structure) are ignored as they play no role in the

analysis when there is a fixed number of firms[6]. We consider the case in which only the home government is policy active so that the profits of a typical foreign firm from exporting to the third market are:

$$\pi_k^* = (p - c_k^*) q_k^*. \qquad \textbf{(3)}$$

Home country welfare from exports to the third market depends positively on profits and negatively on the subsidy payments. It is usually assumed in the literature that profits and government revenue have equal weight in the welfare function. There are several reasons for regarding this as a rather special case. For example, distributional considerations may imply that the incomes taxed to finance the subsidy payments may be attached a higher social value than profits. Also, the government may face a revenue constraint or may not be able to finance the subsidy bill by non-distortionary lump-sum taxation, and will incur administrative costs in managing the tax system. With international capital mobility, foreign ownership may imply that a portion of domestically generated profit is repatriated. In this case, the social cost of funds will clearly be inversely related to the domestically held equity share. Taking some or all of these considerations into account has important, and to an extent separate, consequences. First, as the social cost of funds increases the profit-shifting argument is weakened, given that the government is not prepared to trade off one extra dollar earned in profit with one extra dollar in subsidy payments. Second, the nature of the optimal discriminatory policy is likely to be affected by the extent of the difference between social and private cost of funds. It is therefore likely that the firm-specific optimal policy in our model may be sensitive to the social cost of funds[7]. To examine this issue we follow Neary (1994) and introduce a parameter $\delta \geq 1$ to measure the social cost of funds. The welfare function will then be written as:

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[6] Although we do not model entry and exit of firms, in some equilibria not all the firms will be exporting. In that case, firms may also be selling on the home market and/or on other markets.

[7] Clarke (1988) examines a closed economy asymmetric Cournot model in which the government seeks to maximise tax revenue at given industry price levels. He finds that it is optimal to tax the more efficient firms more than the less efficient ones.

$$W = \sum_i^n \pi_i - \delta \sum_i^n s_i q_i = \sum_i^n \{p - c_i + (1-\delta)s_i\} q_i \,. \qquad \textbf{(4)}$$

This game has two stages and the equilibrium is subgame perfect. The government chooses its subsidies in stage 1 and firms compete in a Cournot manner choosing their output in stage 2. The first-order condition for a typical home firm is:

$$\frac{\partial \pi_i}{\partial q_i} = p - c_i + s_i - b q_i \;\leq 0, \qquad q_i \geq 0, \quad q_i \frac{\partial \pi_i}{\partial q_i} = 0 \qquad \textbf{(5)}$$

and the first-order condition for a typical foreign firm is:

$$\frac{\partial \pi_k^*}{\partial q_k^*} = p - c_k^* - b q_k^* \;\leq 0 \qquad q_k^* \geq 0, \quad q_k^* \frac{\partial \pi_k^*}{\partial q_k^*} = 0 \,. \qquad \textbf{(6)}$$

Note, these first-order conditions imply that the market share of a firm with a low marginal cost net of subsidies is higher than the market share of a firm with a high marginal cost net of subsidies[8].

As in Brander and Spencer (1985) and most of the strategic trade literature, we will assume that quantities are strategic substitutes[9].

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[8] To see this make use of (5) or (6) to obtain: $\alpha_j = \varepsilon\left(\frac{p - \mu_j}{p}\right)$, where is the market share of the *jth* firm, $\varepsilon = p/bQ$ is the elasticity of demand and is marginal cost net of subsidies for firm *j*.

[9] The concept of strategic substitutes is due to Bulow *et al* (1985). The assumption that all quantities are strategic substitutes implies that the marginal profit of any firm is falling in the output of any other firm: . Strategic substitutability is referred to in Dixit (1986) as the "normal" case under Cournot competition.

Assumption 1: Outputs are strategic substitutes for all firms:

$1 + \alpha_L r > 0$ *, where r(Q)=b'Q/b and* α_L *is the market share of the largest firm in the industry.*

This is also the Hahn (1962) sufficient condition for stability of a Cournot equilibrium. Demand is concave if *r(Q)*, the elasticity of the slope, is positive. Assumption 1 thus implies a restriction on the convexity of demand (i.e. *r(Q)* cannot be too negative)[10].

For later reference, we need to derive the comparative-static properties of the output game. The effects of the subsidies on total industry output is obtained by totally differentiating (5) and (6) and adding up the resulting *n+n** equations. The resulting expression is:

$$b\Delta dQ = \sum ds_i \qquad \textbf{(7)}$$

where: $\Delta \equiv (n + n^* + 1 + r) > 0.$

Using (7) in the total derivative of (5) gives the comparative-static properties of an individual home firm's output. This is represented by:

$$b\Delta dq_i = [n + n^* + (1 - \alpha_i)r]ds_i - (1 + \alpha_i r)\sum_{j \neq i}^{n} ds_j \ , \qquad \textbf{(8)}$$

where is the market share of the *ith* home firm. From (8) it is then possible to obtain the following expression for the change in total home output:

$$b\Delta \sum_i^n dq_i = D\sum_i^n ds_i \ . \qquad \textbf{(9)}$$

[10] If demand is convex, i.e. $r<0$, Assumption 1 implies $(1+ \alpha_L r) \leq \{1+[1/(n+n^*)]r\}$ since $\alpha_L \geq 1/(n+n^*)$. Therefore, it must be the case that $(n+n^*+r)>0$.

where $D \equiv 1 + n^* + (1 - \sum_i^n \alpha_i)r$ is positive from Assumption 1[11]. This implies that an increase in any or all of the subsidies will lead to an increase in total home exports. It is also straightforward to show that an increase in any or all of the subsidies will lead to a fall in all of the foreign outputs.

3. Optimal Strategic Export Subsidies

3.1. The First-Best

We first consider the first-best policy which involves firm-specific subsidies. The home government has *n* subsidy instruments and *n* targets in the form of exports for each of the home firms. We model the home government as choosing the optimal levels of exports of each of the home firms taking account of the reactions of foreign exports. Totally differentiate (4) to get:

$$dW = \sum_i^n \{p - c_i + (1-\delta)s_i\} dq_i - b\sum_i^n q_i \, dQ + (1-\delta)\sum_i^n q_i \, ds_i \,. \qquad \textbf{(10)}$$

Make use of (5), the typical home firm's first-order condition, and the total derivative of (5) in (10) to get the following expression for a typical home subsidy:

$$s_i^o = \frac{2-\delta}{\delta} b q_i - b\sum_i^n q_i \left(1 + \frac{\delta - 1}{\delta}\alpha_i r\right)\frac{dQ}{dq_i} \,. \qquad \textbf{(11)}$$

which can be rewritten in terms of the average subsidy. Sum over the *n* subsidies and substitute into (11) to get:

$$s_i^o = \frac{1}{n}\sum_i^n s_i^o + \frac{2-\delta}{2(\delta-1)}\left(\frac{1}{n}\sum_i^n c_i - c_i\right). \qquad \textbf{(12)}$$

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[11] To see that *D* is positive, sum the inequalities $1 + \alpha_k^* r > 0$ across all foreign firms to get: $n^* + \left(1 - \sum_i^n \alpha_i\right) r > 0$ where $\sum_k^{n^*} \alpha_k^* = 1 - \sum_i^n \alpha_i$ is the foreign country's market share.

The first term on the right-hand side represents the average subsidy level, and the second term gives the deviation of any particular subsidy from this average level. The deviation of a typical firm *i*'s subsidy from the average subsidy depends on **(i)** its cost relative to the cost of the average firm in the industry and **(ii)** the size of the social cost of fund parameter. In particular, let firm *i* be more efficient than the average home firm, i.e. $c_i < \frac{1}{n}\sum_j^n c_j$. Then firm *i* will receive a subsidy which is higher than the average industry subsidy, i.e. $s_i^o > \frac{1}{n}\sum_j^n s_j^o$, if and only if $\delta<2$.

Thus,

Proposition 1: *The home government optimal firm specific policy entails a structure of subsidies. Lower cost firms will receive higher export subsidies only if the social cost of funds is sufficiently low.*

Hence, the optimal policy implies a structure of firm-specific subsidies. A uniform policy is optimal in the unlikely event of all firms having identical marginal costs. As in Neary (1994), for sufficiently low levels of δ, the policy prescription is one of picking winners. In Neary (1994), however, the policy implication is that the government should favour winning industries. Our analysis suggests that the government should select winning firms within industries. Neary's argument adds strength to the view that there are sectors in the economy that are more valuable than others. Our result goes further and points at the existence of a comparative advantage in profit-shifting within industries and at the firm level. This comparative advantage in profit shifting, however, should only be exploited if the social opportunity cost of the subsidy bill is not too high. This conclusion adds complexity to the profit shifting argument for an active trade policy. One of the criticisms levelled against strategic trade policy concerns the ability of the government to identify the strategic sectors. The need to be able to identify the winning firms within an industry may be seen as casting further doubts on the feasibility of implementing strategic trade policies.

A second policy implication of Proposition 1 is that the nature of the discriminatory policy will depend on the difference between private and social cost of funds. A pick-the-winners strategy will be optimal only if the social cost of public funds is not too high. Note that the average subsidy in equation (12) can be positive or negative. If the optimal *average* subsidy is negative (i.e. it is a tax), more efficient firms will be taxed less than the average firm provided that $\delta<2$. Thus, when the social cost of funds is sufficiently low, the pick-the-winners policy result holds regardless of whether the optimal policy consists of a structure of subsidies or taxes (or a combination of both). It follows, that if the social cost of funds is sufficiently high, relatively more efficient firms should be more highly taxed/less subsidised[12]. Summing equation (12) over the domestic firms and dividing by *n* yields the average subsidy:

$$\bar{s}^o = \frac{2-\delta}{\delta}\frac{b}{n}\sum_i^n q_i - b\sum_i^n q_i\left(1+\frac{\delta-1}{\delta}\alpha_i r\right)\frac{1}{D} \qquad \textbf{(13)}$$

For $\delta\geq 2$, $\bar{s}^o$ is negative. This implies the following:

Corollary 1: *$\delta>2$ is a necessary condition for the pick-the-winners policy to be reversed and $\delta\geq 2$ is a sufficient condition for the average subsidy to be a tax.*

Proof: the first part follows from (12) and the second part is proved in appendix A.2.

Note that (12) and (13) coincide for $\delta=2$:

$$\bar{s}^o = s_i^o = -\frac{b\sum_i^n q_i(2+\alpha_i r)}{2D} \qquad \textbf{(14)}$$

[12] It is easy to show that when subsidies are chosen optimally, there is an inverse relationship between firms' marginal production costs and equilibrium output levels for *all* values of the social cost of funds. Therefore, the ranking of home firms' outputs is not affected by the "pick-the-winners policy reversal".

That is, at the threshold level of the social cost of funds at which the pick-the-winners policy is reversed, every firm receives the negative subsidy:

Corollary 2: At $\delta=2$ the first-best policy entails a uniform tax.

Hence, the picking-the-winners policy is weakened as δ increases and is reversed at high values of the social cost of funds. The intuition for this result is that the higher the level of δ the higher will be the social opportunity cost of the subsidy bill. When δ exceeds unity the government is directly concerned to minimise total subsidy payments. Low cost firms, as well as having a comparative advantage in rent-shifting, have larger market shares and hence for given per-unit subsidies contribute more to raising the government's total subsidy bill. At sufficiently high levels of δ, the opportunity cost of the subsidy bill dominates the rent-shifting motive and the picking winners policy is reversed.

An interesting issue concerns the size of the social opportunity cost of funds. The empirical literature on the marginal cost of public funds offers a substantial amount of estimates. Although these vary quite widely, the majority of studies suggests that δ may lie between 1.25 and 1.50[13]. Thus, this evidence seems to support the pick-the-winners policy.

3.2. A Special Case: No-Social Cost of Funds

An interesting special case is that in which there is no social opportunity cost of public funds. From (5) it is obvious that for $\delta=1$, there does not exist a first-best interior solution when firms have different marginal costs. Instead we obtain a corner solution. Thus, if the exports of firm *i* are positive when optimally chosen, then there can be no home firm with a marginal cost higher than that of firm *i* exporting a positive output. To set q_j at zero the government must set a firm-specific tax (negative subsidy):

$$s_j \leq -(p - c_j). \qquad \textbf{(15)}$$

[13] Carmichael (1991) obtains an estimate of 1.34; Fullerton (1991) finds $1<\delta<1.25$ while Ballard, Shoven and Whalley (1985) find a range between 1.15 and 1.50.

Only the lowest cost firm receives a subsidy that allows it to produce a positive output. The optimal export subsidy for the lowest cost firm is obtained by combining (5), (10), the expression for dQ/dq_i in (a.2) and the derivative of the foreign reaction function in (a.4). The resulting formula is:

$$s^o = bq\frac{n^* + (1-\alpha)r}{n^* + 1 + (1-\alpha)r} > 0 \qquad \textbf{(16)}$$

where the subscript *i* has been dropped as there is only one home firm active on the market. This is the optimal firm-specific export subsidy for the lowest cost home firm when the social cost of funds is unity[14].

Proposition 2: The home government's optimal firm-specific policy when the social cost of funds is unity is a positive subsidy to the lowest cost firm and a negative subsidy to all other home firms so as to set their exports at zero.

Thus, even in the special case in which $\delta=1$ the optimal export subsidy policy implies a structure of firm-specific subsidies. In this case, however, the pick-the-winner policy prescription is much stronger. Far from trying to reduce the degree of heterogeneity by helping the weaker more than the stronger firms, the government should always support the strongest firm and set all the other home firms' exports at zero, regardless of the number and size of domestic firms. This result is sensitive to our constant marginal cost assumption[15].

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[14] Of course if two firms have the same marginal cost they may both be subsidized. If so, they will receive identical subsidies. Suppose there are $m \leq n$ firms that all have equal costs and these are lower than those of any other home firm then the optimal subsidy to each of these firms is: $s_i = -bq_i\left\{m\sum_k^{n^*}\frac{dq_k^*}{dq_i} + (m-1)\right\}$.

[15] It seems particularly implausible that marginal costs will remain constant if the initial market share of the chosen firm is small (i.e. if *n* is initially large). Clearly, in such a case it is unlikely that the firm will be able to increase its output by the required amount without experiencing capacity constraints or increasing marginal costs. The implications of increasing marginal costs are discussed in Leahy and Montagna (1997).

3.3. The Second-Best

The first-best firm-specific export subsidy policy may not always be a viable option for the government. A major problem certainly lies in the greater informational requirement of the optimal discriminatory policy. Political economy considerations may also mean that the government will not want to favour one producer over another. It is therefore possible to envisage circumstances in which the government is constrained to set a uniform export subsidy for all home firms. Collie (1993) and Von Long and Soubeyran (1997) examine the effect on welfare of a small increase in the uniform subsidy starting at zero[16]. We now generalise their analysis by deriving the optimal uniform subsidy for cases in which the social cost of funds is greater than unity.

From equation (4) the first-order condition for welfare maximisation is:

$$\frac{dW}{ds} = \sum_i^n \left\{ [\, p - c_i + (1-\delta)s \,] \frac{dq_i}{ds} \right\} - b \frac{dQ}{ds} \sum_i^n q_i + \sum_i^n q_i (1-\delta) = 0 \,. \qquad \textbf{(17)}$$

Make use of (5), (7) and (8) in (17) to give the optimal uniform subsidy:

$$s^o = \frac{b}{n} \sum_i^n q_i \left\{ \frac{n^* - n + 1 + (1 - n\alpha_i)r + (1-\delta)\Delta}{\delta D} \right\} \qquad \textbf{(18)}$$

In general, the sign of the optimal uniform subsidy depends on that of the numerator of equation (18) (since the denominator is positive). In the special case in which all the firms within a particular country have equal marginal costs and the social cost of funds is equal to unity, the sign of the optimal subsidy depends only on the relative number of home and foreign firms and on the convexity of demand[17]. The reason why $n>1$ domestic firms works towards an export tax

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[16] Von Long and Soubeyran (1997) also consider the optimal export tax (or subsidy).

[17] This was shown by Dixit (1984) and Krishna and Thursby (1991).

is now well known. When there are more than one home firm these firms do not fully internalise the effects of their output decision on the export price faced by other home firms. In the general demand case, the curvature of the demand function also has a role in affecting the optimal subsidy. In the symmetric firm case with general demands, convex demand makes it more likely that the optimal policy is a tax and concave demand makes it more likely that it is a subsidy. When firms are heterogeneous other considerations arise. With $\delta=1$, it remains the case that if demand is linear the optimal subsidy depends on the relative number of firms. However, if demand is very concave, it is possible for the optimal uniform subsidy to be negative even if n^* is larger than n. As has recently been shown[18], heterogeneity of firms works against a positive optimal subsidy when demand is concave $(r>0)$. This is because in this case a uniform increase in the subsidy raises the output of smaller firms more than that of larger ones, and an increased subsidy can actually reduce the output of some of the most efficient domestic firms. This implication of the analysis may be particularly important if learning-by-doing or consumer switching cost dynamics are present. As already discussed, a non-discriminatory policy would not allow the exploitation of firms' comparative advantage in profit-shifting. The degree of "sub-optimality" of a uniform subsidy may then be higher if (when past output levels are important) less efficient firms see their market share increase at the expense of more efficient competitors.

The introduction of the social cost of funds introduces new considerations. A higher social cost of funds makes a tax more desirable. To be more precise, the uniform subsidy is non-negative if $\delta < \bar{\delta}$ where:

$$\bar{\delta} = \frac{2(n^* + 1 + r)}{\Delta} - \frac{n\sum_i^n \alpha_i^2 r}{\Delta \sum_i^n \alpha_i} \qquad \textbf{(19)}$$

Proposition 3: The optimal uniform subsidy is positive if and only if δ is smaller than $\bar{\delta}$ which is itself less than two.

[18] Similar results are obtained by Collie (1993),Leahy and Montagna (1997) and Van Long and Soubeyran (1997).

See Appendix A.3. for a proof that $\bar{\delta} < 2$. In the linear case this threshold is $\bar{\delta} = \frac{2(n^* + 1)}{n + n^* + 1}$ which is less than two, decreasing in n and increasing in n^*.

Furthermore, as was shown in Corollary 2, for general demand at $\delta=2$ the uniform coincides with the average subsidy and is first-best. In the latter case, the uniform/average subsidy is negative. Also, from equation (13) and (18) it can be shown that for linear demand (i.e. $r=0$) the uniform subsidy equals the average firm-specific subsidy.

4. Concluding Remarks

In the literature on strategic trade policy and international trade under oligopoly it has usually been assumed that all firms in a particular country are identical. An innovation of this paper is to examine the first-best optimal strategic trade policy under oligopoly when firms have different levels of efficiency. In filling this gap in the literature, we have shown that the first-best policy involves a structure of firm-specific subsidies and taxes in which, unless the social cost of funds is high, the government favours the most efficient home firms. A consequence of this is that the uniform export subsidy is typically suboptimal.

In a context characterised by heterogeneous technologies, the government may be tempted to subsidise weaker firms, thus reducing the domestic industry's mean marginal cost of exports. This policy would effectively lead to a reduction in the variability of the home exporters' costs. Our analysis suggests that the nature of the optimal policy crucially depends on the social opportunity cost of public funds. If the social cost of funds is sufficiently low, the government should favour more efficient firms. The *picking-the-winners* policy was shown to be more radical the larger are the cost differences between firms.

Clearly, these conclusions add complexity to the area of strategic trade policy. The need to identify the winning firms within an industry may be seen as casting further doubts on the feasibility of implementing strategic trade policies.

Much work remains to be done in the area of trade policy under oligopoly with heterogeneous firms. In this paper we have restricted attention to competition on a third market.

Competition on the home market and issues of intermarket spillovers need to be addressed. Throughout we have assumed that the number of firms is constant. In standard models, allowing for free-entry leads to the elimination of supernormal profits. When firms are heterogeneous, however, free-entry would only eliminate profits for marginal firms and the profit-shifting rationale for trade policy may not disappear. Finally, this paper rules out the existence of asymmetric information. A natural extension of the model would be to assume that the government does not have perfect information about firms' costs and lacks therefore the ability to pick winners. In future work we would like to address some of these issues.

Appendix

A.1. The foreign reaction function

When the government is carrying out the optimal firm-specific policy it effectively chooses the vector of home exports before the foreigners choose their outputs. To examine the reaction of foreign output to a change in home output totally differentiate the first-order condition of a typical foreign firm given in (6) to get:

$$dq_k^* = -(1+\alpha_k^* r)dQ \qquad \textbf{(a.1)}$$

The total change in output as a result of a change in q_i taking account of the foreign reaction is:

$$\frac{dQ}{dq_i} = 1+\sum_k^{n^*}\frac{dq_k^*}{dq_i} \qquad \textbf{(a.2)}$$

Combine (a.1) and (a.2) to get:

$$\frac{dQ}{dq_i} = \frac{1}{1+n^*+\sum_k^{n^*}\alpha_k^* r} > 0 \qquad \textbf{(a.3)}$$

It is then possible to use (a.3) in (a.1) to obtain:

$$\sum_k^{n^*}\frac{dq_k^*}{dq_i} = -\frac{n^*+\sum_k^{n^*}\alpha_k^* r}{1+n^*+\sum_k^{n^*}\alpha_k^* r} < 0 \qquad \textbf{(a.4)}$$

A.2. Proof of Corollary 1

Let $\phi=\delta-2$ and rewrite equation (13) as:

$$\bar{s}^o = -\frac{\phi}{(2+\phi)}\frac{b}{n}\sum_i^n q_i - b\sum_i^n q_i \left\{\frac{(2+\alpha_i r)+\phi(1+\alpha_i r)}{2+\phi}\right\}\frac{1}{D} \qquad \textbf{(a.5)}$$

For $\phi \geq 0$ (which implies $\delta \geq 2$) this is negative: the first term is non-positive and the second term is unambiguously negative from Assumption 1. **QED.**

A.3. Proposition 3: proof that $\bar{\delta} < 2$

Let $\phi=\delta-2$ and rewrite equation (18) as:

$$s^o = -\frac{b}{n}\sum_i^n q_i \left\{\frac{n(2+\alpha_i r)+\phi\Delta}{\delta D}\right\} \qquad \textbf{(a.6)}$$

From the firms' second order conditions all the $(2+\alpha_i r)$ terms are positive. Hence for $\phi \geq 0$ (i.e. $\delta \geq 2$), (a.6) is unambiguously negative. **QED.**

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